

**COPY**

IN THE MATTER OF

European Patent No. 1 187 690

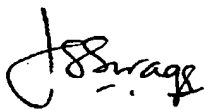
In the name of

ACTech GmbH Advanced Casting  
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56 Grove Road, Tring, Hertfordshire HP23 5PD, England, Translator to the  
firm of Withers & Rogers, of 60 Holly Walk, Leamington Spa,  
Warwickshire CV32 4JE, England, do hereby declare that I am the  
translator of the European Patent No. 1 187 690 and certify that the  
following is a true translation to the best of my knowledge and belief.

Dated this 12<sup>th</sup> day of November 2003.

(Signature)



JILL SUSAN SCRAGG

## Description

The invention relates to the use of a shank tool having fixedly arranged wing-like inserts for milling-like machining of materials that do not produce chips, for the manufacture for moulds, especially heat-resistant casting moulds for the  
5 manufacture of metal castings.

For the manufacture of metal castings, sand moulds that are produced by means of models predominate in practical operation. Since the production of models is expensive, there has long been a requirement in small and medium batch production to produce casting moulds by direct machining of heat-resistant  
10 moulding materials

In DE PS 26 05 687 C3, to produce sand moulds a cutting and milling tool is used to hollow out a mould cavity, the tool being in operative connection with a duplicating milling machine. The milling tool comprises a blade assembly with a cutting element that corresponds substantially to an inverted T-shape and is  
15 fastened to an arm rotating about an axis of rotation. The cutting element is exchangeable, for smoothing the mould surface is curved on its outside, corresponding to the internal diameter of the casting mould to be produced, and viewed in the direction of rotation is shaped on its front side so that a cutting edge is formed. A hardenable greensand tamped down in a moulding box is hollowed out  
20 by means of the cutting edge at a low strength of 2-5 kg/cm<sup>2</sup> before the final strength of the moulding sand has been reached following hardening. This is intended to prevent rapid wear of the cutting edge. The sequence of the process is comparatively difficult to manage, because during hardening of the mould the correct moment in time for the machining has to be ensured. Otherwise, the mould  
25 becomes spoiled if the strength of the moulding sand is low, or if the strength is high, the cutting element quickly becomes useless. Furthermore, the milling tools can only be used for the production of rotationally symmetrical parts.

In contrast, in DD 275 419 A1 it was proposed to machine a casting mould from a single block of moulding material using tools that have no cutting edge  
30 geometry. To produce a cavity in a block of moulding material, use is made of a

device having a rod-shaped driver member driven about an axis, at which driver member at least two non-rigid or semi-rigid, length-adjustable carrier elements are guided. Active machining elements are fixed to these carrier elements and are arranged at equal angular spacing on the driver member in order to avoid  
5 unbalance. Flat parts such as triangular plates, stars or similar, or alternatively spheres or blocks *inter alia* with or without edges can be used as active machining elements. Cables, wire cables, sheet-metal strips, chains or similar are used as non-rigid or semi-rigid carrier elements, and are additionally provided with protective elements to protect them against wear caused by abraded moulding  
10 sand.

To enhance the cutting efficiency, during machining the carrier elements need to achieve as great a rigidity as possible, by arranging the machining elements so that they are displaceable and are braced with respect to one another. The device can be guided on the arm of a computer-controlled robot. Alternatively,  
15 it is possible to control the device using a CNC machine. To improve the surface of the castings, in a concluding work step the inner surfaces enclosing the mould cavity are sprayed with a smoothing agent, which must be uniformly distributed over the surface. It is a disadvantage in this case too that essentially only moulds that depart roughly from rotationally symmetrical parts can be realised. The poor  
20 surface quality of the castings manufactured with the casting moulds, which is attributable to the more or less impact-like action of the tools, is a disadvantage.

Shank milling cutters with cutting tips that have a circular contour are customary for the manufacture of casting moulds. The shank milling cutter described in DE 197 21 900 A1 has at its free end a cutting tip that is fixed to the  
25 shank using clamping screws. The shank has a tip seat with a threaded bore, and the cutting tip has a through-bore. Such a fixing encounters problems, however, when the dimensions of the cutting tips fall below a lower limit. It is therefore difficult to release the cutting tip or to fix it satisfactorily. In addition, it is a disadvantage that the cutting tip is subjected to a high degree of wear when used with materials that

do not produce chips. A constant change of tool is consequently necessary, which is associated with a commensurately high expense.

In order to reduce the outlay on tools arising from the high wear,  
DE 3914074 A1 proposed a milling tool that could be manufactured at reasonable  
5 cost, comprising a cylindrical shank and a flat cutting edge-carrier. At its edges  
furthest from the axis of the shank, the cutting edge-carrier is provided with cutting  
edges. On the front side of the cutting edge-carrier there are provided additional  
frontal cutting tips. The shank is in the form of a drill on one side, so that the milling  
cutter can function as a face cutter. In relation to the axis of the shank, the cutting  
10 edges are arranged at the radially outer end edges of the cutting edge-carrier. The  
cross-section of the milling tool has an S-shaped profile, pointing with the cutting  
edge in the cutting direction. For this reason, the above-described milling cutter can  
be used only with chip-producing materials. It is not possible to use it with materials  
that do not produce chips.

15 Foundry sands that contain bonding agents produce a marked degree of  
erosion at the tool blade, which is caused by wear by cutting at the cutting edges  
and frictional wear on the flanks. For that reason, a cutting effect is guaranteed only  
in the case of new tools, and is therefore limited in time. Wear by cutting produces  
a rounding of the leading edge of the tool, causing additional frictional wear in the  
20 zone lying behind the cutting edge. This frictional wear increasingly wears out the  
external faces and deforms the tool increasingly towards the rear opposite to the  
direction of rotation. The energy corresponding to the friction is converted into heat,  
which can lead to heating of the tool and to a more rapidly increasing wear.

The present invention is based on the problem of constructing a simple  
25 shank tool that can be manufactured at reasonable cost for milling-like machining of  
non-chip-producing materials for the production of heat-resistant casting moulds,  
especially bonding agent-containing casting moulds of sand, such that the shank  
tool remains functional despite unavoidable frictional wear and despite increasing  
erosion. The machining action is intended to be maintained for a relatively long  
30 period of time. Losses due to friction are to be reduced.

That problem is solved in accordance with the invention with the use of a shank tool having a wing-like cutting blade as cutting insert according to claim 1. The minimal blade thickness substantially reduces friction between the blade edges and the surface of the casting mould, with the result that not only is erosion of the cutting blade reduced, but the service life of the tool is also increased. The tool is  
5 consequently especially suitable for high-speed machining, since its mass is reduced and cooling of the blade edges at high speeds is enhanced.

The shank tool proposed for use is assembled from semi-finished products that are easy to manufacture, and can thus be produced at reasonable cost, which  
10 will be explained in detail hereinafter with reference to an exemplary embodiment. Further advantages and constructions of the invention will be apparent from the following description and the subsidiary claims.

In the accompanying drawings in schematic view:

- Figure 1 shows a shank tool with a rectangular cutting blade,  
15 Figure 2 shows a shank tool with a cutting blade with curved blade edge,  
Figure 3 shows a shank tool with a cutting blade with rounded blade edges,  
Figure 4 shows a shank tool with a cutting blade with angled blade edges,  
Figure 5 shows a shank tool with a cutting blade with tapered blade edges,  
Figure 6 shows a shank tool with a tubular shank,  
20 Figure 7 shows a shank tool with cutting blades arranged with double symmetry,  
Figure 8 shows a shank tool with a cutting blade curved convexly in the direction of rotation,  
Figure 9 shows a shank tool with a cutting blade angled convexly in the direction of rotation,  
25 Figure 10 shows a shank tool with a cutting blade angled convexly in the direction of rotation with obliquely set blade edges.  
30

The shank tool illustrated in Figure 1 for milling-like machining of materials that do not produce chips and, especially in the case of the manufacture of heat-resistant casting moulds for metal castings, can contain granular crystalline sand,

essentially comprises two simple parts, which are joined together in a suitable manner, for example, by positive engagement, welding, soldering or adhesion.

The elongate and cylindrical shank 1 rotatable about its longitudinal axis 2 comprises an upper shank end portion 3, which can be releasably connected to a tool chuck for rotary material-removing tools. As shown in Figure 6, the shank 1 is in the form of a tubular hollow body 5. A tubular hollow body 5 offers a considerable saving of weight, the advantage of which is especially apparent at very high rotational speeds. A further advantage can comprise the fact that the shank 1 is in the form of a tubular hollow body 5 at least in the region of the cutting blade mounting 4. In this way, when deep parts are being machined, the hollow body 5 can be extended with an appropriate cylindrical shank end portion 3.

At its free end portion 6, that is, in the region of the cutting blade mounting 4, the shank 1 is provided with an axially extending, groove-like cutout 7 for receiving the cutting blade 8. As shown in Figure 7, for example, two groove-like cutouts 7 are provided, so that two cutting blades 8 are arranged with double symmetry. In the case of a tubular hollow body 5, the cutting blades 8 can be interleaved at the longitudinal axis 2 by putting them together through two opposing half-incisions, and are fixed in the cutout 7 in an especially simple manner, for example, by soldering. This ensures they are held securely at high speeds.

The cutting blade 8 can be produced as a stamped part by stamping from a blank of sheet steel or wear-resistant sheet steel, wherein the invention is not intended to be limited to the said exemplary embodiments. On the contrary, suitable materials and semi-finished articles not specifically mentioned can also be used, provided that they lie within the scope of the patent claims. This applies in particular to composite materials, fibre-reinforced materials or high-strength materials respectively ceramic or fibre-reinforced ceramic elements.

The cutting blade 8 shown in Figure 1, viewed in the direction of feed 9, is provided on the front flat face 11 with a non-cutting blade edge 12, which is arranged at right angles to the flat face 11 when a simple punched blank is used. In this case, the blade thickness can be comparatively small. The blade thickness

can be from 0.1 mm – 5.00 mm. The blade thickness will preferably be 0.2 – 1.00 mm.

In particular, the blade thickness shall not be selected to be any larger, so that the tangential angle of the flank of the leading blade edge 12 is close to or equal to zero. When using high-strength materials or when using composite materials, the blade edge 12 and the trailing edge 13 of the cutting blade 8 lying behind the blade edge 12, seen in the direction of feed 9, can be provided with a radius or can be rounded. With a small tangential angle and owing to the rounding, the heat due to friction and wear are reduced.

An additional reduction in friction in the region of the trailing edge 13 can be achieved with a cutting blade 8 that comprises a base material of steel and on the front face 11 is joined to an anti-wear covering 15 having a higher resistance. Any desired hard materials or metal compounds containing hard materials or a metal alloy containing hard materials, or composite materials can be provided as the anti-wear covering 15. The anti-wear covering 15 applied to the front flat face 11 reduces the wear on the blade edge 12. The trailing edge 13 on the cutting blade 8 of steel is subject to greater wear because of its lower resistance, producing a rounding of the face, which has a lower resistance to friction.

The cutting blade 8 can be of many different forms. In the machining of casting moulds, different shank tools can therefore be used in succession when using CNC-controlled machine tools with automatic tool change, which enables the manufacture of complicated moulds to be substantially simplified. In its basic form, the cutting blade 8 comprises a square or rectangular blank, as shown in Figure 1 and Figures 3 to 10. In Figure 3, the cutting blade 8 is provided at its front edge 16 with a rounding 17 or in Figure 4 at its front edge with corners 18 cut to form angles.

The cutting blade 8 shown in Figure 2 has an outer contour in the form of an arc of a circle 19 and in Figure 5 the contour of a trapezium 21 can be seen, which produces a cone on rotation of the shank tool about the longitudinal axis 2.

In an especially advantageous construction of the shank tool, parallel to the longitudinal axis 2 the cutting blade 8 can have a curvature 22 that is convex in the

direction of rotation 24, as shown in Figure 8, or can have a profile 23 that is convexly canted in the direction of rotation 24, as shown in Figure 9. When the cutting blade 8 is formed from a resiliently deformable or springy sheet material of low sheet thickness, the curvature 22 can be reduced at higher speeds, such as those in high-speed machining. In this way, with increasing wear of the cutting blade 8 as the speed increases, the tool radius can be kept constant. Cutting blades 8 of metal that have a high wear resistance are especially suitable for this process. By means of the described shank tools, filigree casting moulds that have a very smooth mould surface can be produced using moulding sand.

10           In order to remove the machining residues occurring as the material is abraded, it is an advantage for the cutting blade 8 to have shovel-like canted profiles 25, as shown in Figure 10, to achieve a ventilator fan effect; the canted profiles have a blade angle 26 to the longitudinal axis 2. The abraded material residues can thus be carried away from the machining point, mainly in the axial  
15   direction.



## **Patent Claims**

1. Use of a shank tool having fixedly disposed, wing-like inserts for the milling-like machining of materials that do not produce chips, for the manufacture of heat-resistant casting moulds, in particular of bonding agent-containing sand moulds for the manufacture of casting moulds made of metal, and having a shank (1) rotatable about its longitudinal axis (2), which is capable of being connected in a releasable manner to a drive device and is provided at its free end portion (6) with at least one cut-out (7) in the form of a groove extending in an axial direction and with a flat cutting blade (8) which, seen in the direction of feed (9), is provided on its front face with a non-cutting blade edge (12).
  2. Use according to patent claim 1, characterised in that the cutting blade (8) is a stamped part produced by stamping from a flat blank of steel, wear-resistant steel, or a suitable wear-resistant material, and is provided with an outer blade surface standing at right angles to the flat face (11).
  3. Use according to patent claim 1 to 2, characterised in that the blade edge (12) and the rear edge (13) of the cutting blade (8) located behind the blade edge (12) when seen in the direction of feed (9) is provided with a radius or is rounded.
  4. Use according to patent claim 1 to 3, characterised in that the cutting blade (8) has the basic form of a square or rectangular blank and/or is provided on its front face with roundings (17) or with corners (18) cut to form angles.
  5. Use according to patent claim 1 to 3, characterised in that the cutting blade (8) is provided with an arc-shaped or tapered external contour.
  6. Use according to patent claim 1 to 5, characterised in that the cutting blade (8) is provided with a curvature (22) or a fold (23) parallel to the longitudinal
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axis (2), wherein the convex side of the curvature (22) or fold (23) respectively is arranged pointing in the direction of rotation (24).

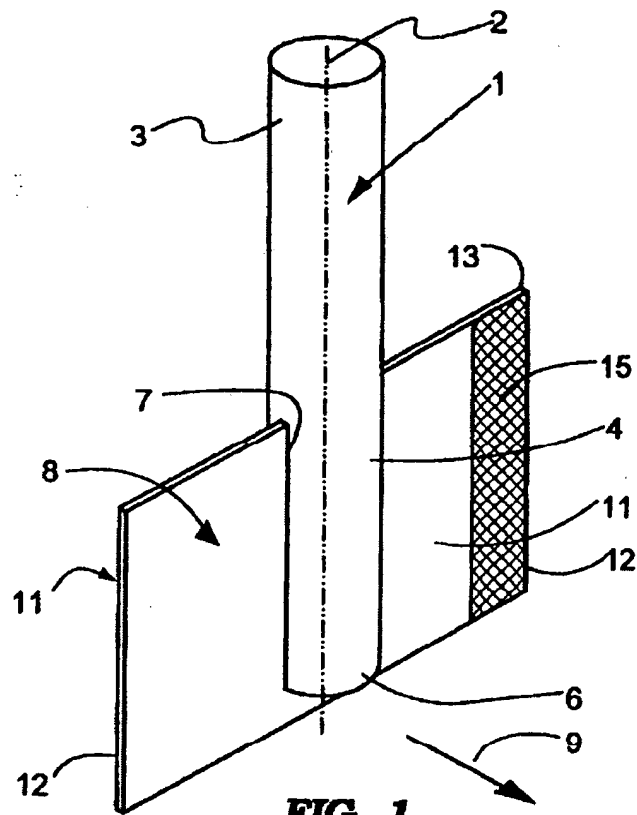
7. Use according to patent claim 1 to 6, characterised in that the cutting blade (8) has shovel-like blade folds (25) to achieve a ventilator fan effect, these being arranged with a blade angle (26) inclined with respect to the longitudinal axis (2).

8. Use according to patent claim 1 to 7, characterised in that the cutting blade (8) is formed from a metallic blade material, exhibiting high strength and capable of elastic deformation or springing.

9. Use according to one or more of patent claims 1 to 8, characterised in that the cutting blade (8) comprises a basic material of steel and is provided on the front flat face (11) with a wear protection covering (15) of a hard material or metal compound containing hard materials, or a metal alloy containing hard materials.

10. Use according to one or more of patent claims 1 to 9, characterised in that at least in the region of the cutting blade mounting (4) the shank (1) comprises a tubular and cylindrical hollow body (5).

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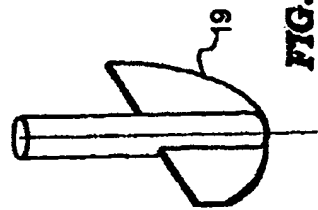


FIG. 2

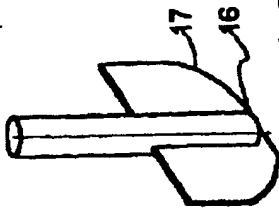


FIG. 3

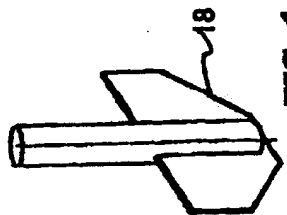


FIG. 4

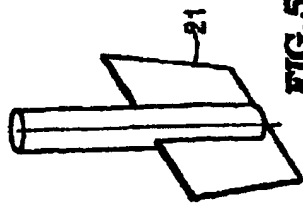


FIG. 5

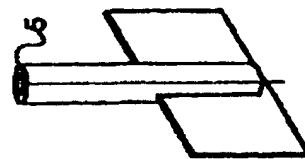


FIG. 6

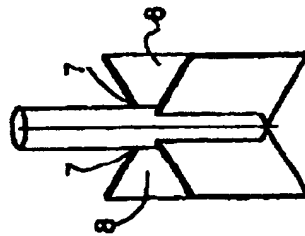


FIG. 7

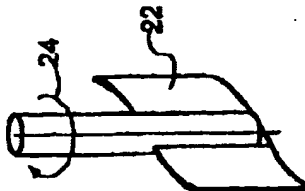


FIG. 8

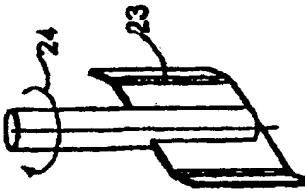


FIG. 9

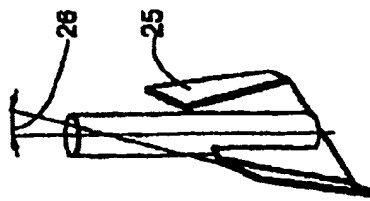


FIG. 10